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AN EVALUATION OF 148 COMPOUNDS AS AVIAN IMMOBILIZING AGENTS

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AN EVALUATION OF 148 COMPOUNDS AS AVIAN IMMOBILIZING AGENTS

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Abstract.--From 1961 to 1969, some 148 compounds were tested for immobilization of red-winged blackbirds (Agelaius phoeniceus) and starlings (Sturnus vulgaris). Of these, 25 showed enough promise to warrant advanced testing on seven additional species of wild birds: the common grackle (Quiscalus quiscula), common pigeon (Columba livia), house finch (Carpodius mexicanus), house sparrow (Passer domesticus), mallard duck (Anas platyrhynchos), ring-necked pheasant (Phasianus colchicus), and yellow-headed blackbird (Xanthocephalus xanthocephalus). Although no single compound was best suited for immobilizing all of the nine species tested, Banol (6-chloro-3,5-xylyl N-methyl carbamate) Dowco, 161(O-ethyl-, O-2,4-dichlorophenyl phosphoroamidate), metomidate [methyl ester of imidazole-5-carboxylic acid; 1-(α-methylbenzyl)], and metomidate HCl possessed exceptional activity on three or more of the species tested. Of the species tested, redwings and house finches were the most sensitive to immobilizing agents, and pheasants the least.

INTRODUCTION

Compounds that anesthetize or immobilize birds are finding increasing use throughout the world. They are used during surgery on captive wild birds (1,2,6,20,25,29,30,32,38,43,45,57) and domestic fowl (21,23,34,35,37, 41,59,62), and less potent compounds have been used to promote growth and reduce antagonistic or cannibalistic tendencies in poultry (36,71). Perhaps the newest use of avian immobilizing agents, and the one with the most potential for future development, is in wildlife biology and management. Not only are these compounds now being used to capture wild birds for banding and other scientific pursuits (3,11,13,17,27,28,39,44,46,52,53,58,66,72,74), but also they are being more and more often considered to alleviate agricultural and urban bird problems (4,7,8,9,10,12,14,15,18,19,22,26,31,33,47,48, 50,51,54,55,56,63,69,70,75). This latter use will probably expand rapidly as the hazards of nonselective toxicants are realized.

Although a considerable amount of literature has been published in the last three decades on the immobilization of birds, a comparative evaluation of the most effective agents for various avian species has never been made. This paper presents this information on 148 physiologically active compounds.

We wish to acknowledge the invaluable help of Ronald B. Brunton who assisted in many of the laboratory studies contained herein, and Ann H. Jones, Jerome F. Besser, Joseph L. Guarino, and Richard R. West for the help that they have graciously given in editing this manuscript.

PROCEDURES

In 1961, the Denver Wildlife Research Center began a program of screening immobilizing agents for possible use in bird damage control. Compounds purchased or solicited from chemical and pharmaceutical companies were first screened on starlings (Sturnus vulgaris) and red-winged blackbirds (Agelaius phoeniceus), two species often involved in agricultural and urban bird problems in the United States. Compounds active in this initial screening were then tested on other species that commonly or occasionally cause damage--mallard ducks (Anas platyrhynchos), ring-necked pheasants (Phasianus colchicus), common pigeons (Columba livia), common grackles (Quiscalus quiscula), yellow-headed blackbirds (Xanthocephalus xanthocephalus), house finches (Carpodius mexicanus), and house sparrows (Passer domesticus). Canada geese (Branta canadensis), mourning doves (Zenaidura macroura), common crows (Corvus brachyrhynchos), brown-headed cowbirds (Molothrus ater), and white-crowned sparrows (Zonotrichia leucophrys) were also tested when available.

Three criteria were established to select compounds with the greatest potential:

1. The median temporary immobilizing dose (TI_{50}) should be 32 mg/kg or less when a compound was administered orally to redwings or starlings. Temporary immobilization was arbitrarily defined as the point at which a bird lost complete control over wing and leg movements. We did not further define the various stages of immobilization as have others (46,49,50,51).

2. The compound should have a safety factor ($SF = TI_{50}/LD_{50}$) of at least 3 for the bird species tested.

3. It should be well accepted by birds.

By adhering to these criteria we felt that an effective dose for immobilizing or capturing small to medium-sized birds (20-100 grams) could be put on one bait particle so that there would be minimum, acceptable avian mortality in the field. Larger birds would require multiple baits for immobilization.

Screening tests were conducted by dosing the birds orally as described by DeCino et al. (16) and Schafer et al. (58). Test birds were wild-trapped and held in captivity for 2 to 20 weeks before treatment; none were tested more than once. TI_{50}'s and LD_{50}'s were calculated by the method of Thompson and Weil (64,65,68). Confidence limits ($\alpha = 0.05$) were calculated whenever possible but are not listed in the tables in order to conserve space.

RESULTS

INITIAL SCREENING

From 1961 to 1969, 148 compounds were screened for immobilization activity on redwings and starlings. The test results are given in table 1. For discussion, they have been grouped into five categories according to the compounds' gross pharmacological activity on mammals.

Anesthetics

General anesthetics are compounds that reversibly depress the central nervous system, producing loss of consciousness, analgesia, and muscular relaxation with minimal depression of vital life functions.

Local anesthetics, when topically applied, reversibly abolish sensory impulses (i.e., pain) but, because of poor absorption, do not produce significant effects on other portions of the body. Thus, the primary use of these compounds is in local surgery requiring the suppression of pain. Oral ingestion of large doses results in anesthetic effects similar to those observed with general anesthetics.

Of 19 anesthetics screened, four satisfied our criteria on redwings (butacaine sulfate, metomidate, metomidate HCl, and phencyclidine), and one on starlings (phencyclidine) (table 1). As expected, general anesthetics were more effective than local anesthetics in producing immobilization; of five general anesthetics tested, four showed activity, whereas only one of 14 local anesthetics did so.

Sedatives and hypnotics

Sedatives and hypnotics are pharmacologically considered somewhat less active than anesthetics. Although they act on the higher brain centers like anesthetics and induce some depression of the central nervous system, they do not suppress pain. As a rule, these compounds are well absorbed orally; their effects last for varying lengths of time.

Of 34 sedatives and hypnotics tested, the barbiturates were the most active. Eight out of 15 met our criteria on redwings (allobarbital, butalbital, butethal, mephobarbital, pentobarbital, secobarbital, talbutal, and thiopental sodium), but none on starlings (table 1). Of the remaining 19 compounds, only four (chloralose, ethinimate, mecloqualone, and phenaglycodol) met our criteria on redwings, and only chloralose on starlings.

Tranquilizers

Tranquilizers act less on the mammalian higher brain centers than sedatives and hypnotics and are generally considered pharmacologically less potent. Although they primarily affect the lower brain centers and do not

involve conscious thought processes, they are generally active orally and produce their effects for prolonged periods of time.

Of 33 tranquilizers, only four met our criteria on redwings (chlordiazepoxide, diazepam, SKF 10812A, and trifluoperidol), and none on starlings (table 1).

Myoneural agents

Myoneural agents immobilize by inhibiting the contraction of striated muscle at the neuromuscular junction. This effect can be produced by three major mechanisms, but is most often observed with cholinesterase inhibition. Organophosphate and carbamate pesticides in use today rely on this mechanism for their killing power. Because the reaction at myoneural junctions is a graded response (the more inhibitor, the more inhibition), there is a possibility of producing immobilization but not death. This is easiest to accomplish with reversible cholinesterase inhibitors like the phenyl N-methyl carbamates, because their effects are generally short-lived. Organophosphates, which inhibit more permanently, are less likely candidates.

Of 47 myoneural agents tested, 13 met our criteria on redwings (ACD 7029, Banol, Dowco 160, Dowco 161, H 5727, H 9699, matacil, methiocarb, RE 5305, RE 5454, RE 5655, SD 8530, and SD 8786), and 4 on starlings (Banol, Dowco 161, H 5727, and RE 5454). Although some of these data have previously been reported (58), they are repeated here for comparison. Of the 13 active compounds, 11 were phenyl N-methyl carbamates.

Miscellaneous compounds

Of 25 compounds tested, only 3 (nicotine sulfate, pentazocine, and tremorine) met our criteria on redwings, and none on starlings (table 1).

ADVANCED TESTING

Of the 148 compounds screened on redwings and starlings, 36 fulfilled our criteria for active avian immobilizing agents. Twenty-five of these were tested on 7 additional species of wild birds (table 2).

Inspection of the data in table 2 suggested that there was an order among the species in their sensitivity to immobilizing agents. To test this hypothesis, the TI_{50}'s for the 17 compounds used on all 9 species were analyzed by the sum of ranks procedure (24). For each compound, the most sensitive species was assigned rank 1, the second most sensitive, rank 2, and so on. The scores (sums of ranks for the 17 compounds) were as follows: house finch, 38.5; red-winged blackbird, 45.5; house sparrow, 74.5; yellow-headed blackbird, 79.5; mallard duck, 86.5; common pigeon, 94.5; common grackle, 102; starling, 111.5; ring-necked pheasant, 132.5. The mean sum of ranks was 85, and the 95 percent confidence limits were 54 and 114. Thus, the house finch and redwing were significantly more sensitive to immobilizing agents than the other species, and the ring-necked pheasant was significantly more resistant.

Although only one of the compounds in table 2 (phencyclidine) met our criteria for all 9 species, several appeared promising for certain species. At this stage we added two more criteria:

4. Average induction time (time between dosing and immobilization) at doses between the TI_{50} and LD_{50} should be between 5 and 14 minutes.

5. Average duration of immobilizing effects at doses between the TI_{50} and LD_{50} should be between 1½ and 3 hours.

Table 3 gives a summary of the most promising immobilizing agents for each species (including results of limited tests with five species not shown in table 2). Only compounds that fulfilled the first three criteria are included. Those marked with one asterisk fulfilled either the fourth or fifth criterion and should be considered further. Those marked with two asterisks fulfilled both the fourth and fifth and appear the most likely candidates for field use.

For each of the nine major species except pheasants, there was at least one compound that met all five criteria. However, no single compound was active on enough species to be considered an "all-purpose" immobilizing agent. Pentobarbital met all five criteria for the largest number of species (five). Two other compounds, diazepam and chloralose, were active on a wider variety of species, but had too long an induction time in many cases. Phencyclidine was also active fairly widely, but its effects generally lasted too long. In situations where slow action is acceptable, these last three compounds may be useful for a variety of species at one time. For the best results, however, it appears that immobilizing agents, like so many other biologically active compounds, should be chosen for particular situations with a single target species in mind.

REFERENCES

1. Arnall, L.
   1961a. Anesthesia and surgery in cage and aviary birds. (I) Vet. Rec. 73, no. 7, p. 139-142.
2. 1961b. Anesthesia and surgery in cage and aviary birds. (II) Vet. Rec. 73, no. 8, p. 173-178.
3. Bachrach, A.
   1954. Strictly for the birds. Vet. Excerpts 14, p. 102.
4. Bailey, R. E.
   1953. Surgery for sexing and observing gonad condition in birds. Auk, vol. 70, no. 4, p. 497-499.
5. Belloff, G. B., and B. Hsu.
   1963. A water soluble tranquilizer for handling broilers and replacement pullets. Avian Dis., vol. 7, no. 1, p. 50-55.
6. Bordet, R., J. L. Briand, and J. L. Flipot.
   1962. Some comments on anesthesia in monkeys and birds. Nordish Veterinaer Med., 14 (Suppl. 1), p. 341-343.

7. Borg, K.
1955. Om chloralosen och dess anvandning vid fangst av krakoch masfaglar duvor, etc. Viltrevy vol. 1, no. 1, p. 88-121.
8. Borg, K.
1956. Use of chloralose for destruction of injurious birds. Z. Jagdwissench, vol. 2, no. 3, p. 180-182.
9. Colquhoun, M. K.
1943. Preliminary trials with a narcotic bait for the control of wood-pigeons. Rep. to the Ag. Res. Council (unpublished). Great Britain.
10. Colquhoun, M. K.
1946. Narcotic baiting. Rep. to the Ag. Res. Council (unpublished). Great Britain.
11. Condy, J. P.
1965. A technique for capturing Abdim's Storks (Lichtenstein). Ostrich, vol. 36, no. 3, p. 121-122.
12. Cornwell, P. B.
1966. Int. Pest Contr., vol. 8, no. 5, p. 10-13.
13. Crider, E. D., and J. D. McDaniel
1967. Alphachloralose used to capture Canada geese. J. Wildl. Mgmt., vol. 31, no. 2, p. 258-264.
14. Danzel, L.
1949. Contribution de la chloralose a latte contre les corbeaux. Phytoma, vol. 4, p. 18.
15. Daude, J. L.
1942. Capture et destruction des corbeaux, pies et autres oiseaux nuisibles aux recoltes. Bull. Akad. Med., Paris, vol. 126, p. 452.
16. DeCino, T. J., D. J. Cunningham, E. W. Schafer, Jr.
1966. Toxicity of DRC-1339 to starlings. J. Wildl. Mgmt., vol. 30, no. 2, p. 249-253.
17. Delius, J. D.
1966. Pentobarbital anesthesia in the herring and lesser black-backed gull. J. Small Animal Practice, vol. 7, p. 605-609.
18. Dietzsch, von Klaus
1964. Die Umsetzung von 1-Methylcyclopentanol-1-und cyclohexanol mit Natriumazid. J. Prakt. Chem., vol. 4, no. 3, p. 43-46.
19. Dixmeras, J., and J. Giban
1950. La lutte contre les corbeaux. Bull. Tech. Ing Serv. Agric. 49, p. 275.
20. Donavon, C. A.
1958. Restraint and anesthesia of cage birds. Vet. Med., vol. 53, p. 541.
21. Durant, A. J.
1953. Removing the vocal cords of fowl. J. Am. Vet. Med. Ass., vol. 122, p. 14-17.
22. El-Hewehi, Z.
1964. Notiz uber D-Glucochloralose. J. Parakt. Chem., vol. 23, no. 4, p. 43-46.
23. Fretz, W. C.
1932. Anesthetizing poultry. Vet. Med., vol. 27, p. 109.
24. Friedman, M.
1937. The use of ranks to avoid the assumption of normality implicit in the analyses of variance. J. Amer. Stat. Ass., vol. 32, p. 675-701.

25. Gandal, C. P.
1956. Satisfactory general anesthesia in birds. J. Am. Vet. Med. Ass., vol. 128, p. 332.
26. Giban, J.
1947. La lutte contre les pies et les corbeaux. Rev. Hort. (Paris), vol. 30, p. 433.
27. Giban, J.
1950. Recherches sur l'action da chloralose on glucochloral chex les oiseaux. Ann. Inst. Nat. Rech. Agron., Paris Serc 1, p. 337.
28. Giban, J.
1954. Baguay des Corvides. Phytoma 56, p. 27.
29. Gillispie, J. M., and W. G. Magrane.
1956.. A new anesthetic for veterinary use. Vet. Med., vol. 51, p. 185.
30. Graham-Jones, O. (Ed.)
1964. Small animal anaesthesia. Pergamon Press, Oxford, 260 p.
31. Guillaume, A.
1951. Les appats enpoisonees au gluco-chloral. Phytoma, vol. 29, p. 17.
32. Halloran, P. O. C.
1955. A bibliography of references to diseases of wild mammals and birds. Am. J. Vet. Res., vol. 16, no. 61, pt. 2, 465 p.
33. Henkes, R.
1967. Wings of destruction. World Farming, vol. 10, no. 6, p. 28-32.
34. Hill, K. J., and D. E. Noakes.
1964. Cyclopropane anesthesia in the fowl. In (Ed. Graham-Jones, O.) Small animal anaesthesia, Pergamon Press, Oxford, p. 123.
35. Hole, N.
1933. Chloral hydrate as a general anesthetic for the fowl. J. Comp. Path. and Therap., vol. 46, p. 47.
36. Huston, T. M., and K. N. May.
1961. The use of sodium pentobarbital sedation as an aid in catching and plucking poultry. Poult. Sci., vol. 40, no. 2, p. 434-440.
37. Jordan, F. T. W., J. Stanford, and A. Wright.
1960. Anesthesia in the fowl. J. Com. Path., vol. 90, p. 437.
38. Keymer, T. F.
1958. The diagonsis and treatment of common psittacine diseases. Mod. Vet. Practice, vol. 39, p. 22.
39. Lindau, L.
1962. Experiments with tranquilizers in birds. Nordish Veterinaer. Med., vol. 14, Suppl. 1, p. 112-117.
40. Lumb, W. V.
1963. Small animal anesthesia. Lea & Febiger, Philadelphia, 420 p.
41. Marley, F., and J. P. Payne.
1964. Halothane anaesthesia in the fowl. In (Ed. Graham-Jones, O.) Small animal anaesthesia. Permamon Press, Oxford, p. 127.
42. Marsboom, R., J. Mortelmans, and I. Vercruysse.
1964. R 7315. A new hypnotic agent in birds. Int. Zoo Yearbook, vol. 5, p. 200-201.
43. Marsboom, R., J. Mortelmans, and I. Vercruysse.
1965. Methoxymol induced hypnosis in birds. Bull. de la Societe Royale de Zoologie d Anvers, vol. 35, p. 3-7.

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44. Martin, L. L.
1967. Comparison of methoxymol, alpha-chloralose, and two barbiturates for capturing doves. Proc. Ann. Conf. Southeast. Ass. Game and Fish Comm., New Orleans, La., vol. 21, p. 193-200.
45. Mortelmans, J., and I. Vercruysse.
1966. Anesthesie bij Vogels. Zoo vol. 31, p. 168-169.
46. Mosby, H. S., and D. E. Cantner.
1956. The use of Avertin in capturing wild turkeys and as an oral-basal anesthetic for other wild animals. Southwestern Vet., vol. 9, no. 2, p. 132-136.
47. Moser, C. M.
1960. Control of unwanted birds with anesthetic foodstuffs. Sixth Pan Amer. Cong. of Pharm. & Biochem., Dec. 7, 1960.
48. Moser, C. M.
1965. Anesthetize pest birds with tribromoethanol for humane removal. Amer. City, vol. 80, p. 30.
49. Murton, R. K.
1962. Narcotics v. wood-pigeons. Agriculture, vol. 69, no. 7, p. 336-339.
50. Murton, R. K.
1963. Stupefying wood pigeons. Agriculture, vol. 70, no. 10, p. 500-501.
51. Murton, R. K., A. J. Isaacson, and N. J. Westwood.
1963. The use of baits treated with alpha-chloralose to catch wood pigeons. Ann. Appl. Biol., vol. 52, p. 271-293.
52. Murton, R. K., A. J. Isaacson, and N. J. Westwood.
1965. Capturing columbids at the nest with stupefying baits. J. Wildl. Mgmt., vol. 29, no. 3, p. 647-649.
53. Peek, J. M.
1966. Chlordiazepoxide and pentobarbital as tranquilizers for cowbirds and coturnix quail. J. Amer. Vet. Med. Ass., vol. 149, no. 7, p. 950-952.
54. Potts, R. M., and D. J. Womeldorf.
1960. Pigeon control in Fresno, California. Vector Views, vol. 7, no. 10, p. 59-62.
55. Ridpath, M. G., R. J. P. Thearle, D. McCowan, and F. J. S. Jones.
1961. Experiments on the value of stupefying and lethal substances in the control of harmful birds. Ann. Appl. Biol., vol. 49, no. 5, p. 77-101.
56. Ryan, C.
1968. Fighting the blackbird plague. Farm Quarterly Summer, p. 38, 126-129.
57. Sanger, V. L., and H. B. Smith.
1957. General anesthesia in birds. J. Amer. Vet. Med. Ass., vol. 131, p. 52.
58. Schafer, E. W., R. I. Starr, D. J. Cunningham, and T. J. DeCino.
1967. Substituted phenyl N-methylcarbamates as temporary immobilizing agents for birds. J. Ag. Food Chem., vol. 15, no. 2, p. 287-289.
59. Schwarte, L. H.
1943. Poultry surgery in diseases of poultry by H. E. Biester and L. H. Schwarte. Iowa State College Press, Ames, Iowa, p. 828.

60. Speidel, W. C.
1963. Pickled pigeons. Time.
61. Starr, R. I., J. F. Besser, and R. B. Brunton.
1964. A laboratory method for evaluating chemicals as bird repellents. J. Agr. Food Chem., vol. 12, no. 4, p. 342-344.
62. Sykes, A. A.
1964. Some aspects of anaesthesia in the adult fowl. In (Ed. Graham-Jones, O.) Small animal anaesthesia. Pergamon Press, Oxford, p. 117.
63. Thearle, R. J. P.
1960. The use of narcotics in catching harmful birds. Ann. Appl. Biol., vol. 48, p. 414-415.
64. Thompson, W. R.
1947. Use of moving averages and interpolation to estimate median effective dose. Bacteriol. Rev. 11, p. 115-145.
65. Thompson, W. R., and C. S. Weil.
1952. On the construction of tables for moving average interpolation. Biometrics 8, p. 51-54.
66. Tomlinson, J. T.
1967. Sedatives interfere with walking more than flying. Wilson Bulletin, vol. 79, no. 2, p. 242-243.
67. Weigand, G.
1965. Orienting experiments in the control of crows with alpha-chloralose. Nach. Deut. Planzensuchutzdienstes, vol. 17, no. 7, p. 108-110.
68. Weil, C. S.
1952. Tables for convenient calculation of median effective dose (LD_{50} or ED_{50}) and instructions in their use. Biometrics 8, p. 249-263.
69. Westhues, M., and R. Fritsch.
1961. De Narkose der tiere. Parey, Berlin.
70. Wight, H. M.
1953. A suggested method of capturing birds with a narcosis-producing drug. Proc. Midwest Wildlife Conf., December 1953, 2 p.
71. Wilgus, H. S.
1960. Reserpine for tranquilizing geese. Second Conf. Use of reserpine in poultry production. University Press, Minn.
72. Williams, L. E., Jr.
1966. Capturing wild turkeys with alpha-chloralose. J. Wildl. Mgmt., vol. 30, no. 1, p. 50-56.
73. Williams, L. E., Jr.
1967. Preliminary report on methoxymol to capture turkeys. Proc. Ann. Conf. Southeast. Ass. Game and Fish Comm., vol. 21, p. 189-193.
74. Williams, L. E., Jr., D. H. Austin, and J. Peoples.
1966. Progress in capturing turkeys with drugs applied to baits. Proc. Ann. Conf. Southeast Ass. Game and Fish Comm., vol. 20, p. 219-226.
75. Woronecki, P. P., J. L. Guarino, and J. W. De Grazio.
1967. Blackbird damage control with chemical frightening agents. Proc. Vert. Pest Cont. Conf., vol. 3, p. 54-56.

TABLE 1. Results of initial screening on starlings and red-winged blackbirds

Compound	Starling			Red-winged Blackbird		
	TI_{50} (mg/kg)	LD_{50} (mg/kg)	SF (LD_{50}/TI_{50})	TI_{50} (mg/kg)	LD_{50} (mg/kg)	SF (LD_{50}/TI_{50})
General Anesthetics						
Hydroxydione	> 100	> 100	--	100	> 100	> 1.0
Metomidate	75	> 100	> 1.3	18	56	3.2
Metomidate HCl	42	178	4.3	13	100	7.5
Phencyclidine	2.4	242	100	1.3	42	32
Tribromoethanol	178	> 316	> 1.8	56	320	5.6
Local Anesthetics - Benzoic Acid Esters						
Butacaine SO_4	75	> 100	> 1.3	24	100	4.2
Butambem	> 100	> 100	--	--	100	--
2-Chloroprocaine HCl	--	--	--	> 100	> 100	--
Prilocaine	> 100	> 100	--	> 100	> 100	--
Procaine	> 953	> 953	--	--	--	--
Tetracaine	> 100	> 100	--	75	> 100	> 1.3
Tricaine	> 100	> 100	--	> 100	> 100	--
Zolamine	> 100	> 100	--	> 100	> 100	--
Local Anesthetics - Other						
Dibucaine HCl	--	100	--	--	42	--
Diperidon HCl	> 100	> 100	--	75	> 100	> 1.3
Isopentylhydrocupreine	> 100	> 100	--	> 100	> 100	--
Oxethazine	--	--	--	75	> 100	> 1.3
Pramoxine	> 100	> 100	--	> 100	> 100	--
Sedatives and Hypnotics - Barbituates - Short and Ultrashort Duration						
Butalbital	42	> 100	> 2.4	24	100	4.2
Cyclobarbital	--	--	--	100	> 100	> 1.0
Pentobarbital	56	> 100	> 1.8	7.5	75	10
Secobarbital	> 100	> 100	--	13	75	5.6
Thiopental Na	56	> 100	> 1.8	13	133	10

TABLE 1 (Continued)

Compound	Starling			Red-winged Blackbird		
	TI_{50} (mg/kg)	LD_{50} (mg/kg)	SF (LD_{50}/ TI_{50})	TI_{50} (mg/kg)	LD_{50} (mg/kg)	SF (LD_{50}/ TI_{50})
Sedatives and Hypnotics - Barbituates - Intermediate Duration						
Allobarbital	42	> 100	> 2.4	24	100	4.2
Butethal	75	> 100	> 1.3	24	178	7.5
Hexobarbital Na	--	--	--	42	> 100	> 2.4
Probarbital Na	56	> 100	> 1.8	24	42	1.8
Talbutal	42	> 100	> 2.4	24	75	3.2
Thiamyl Na	--	--	--	--	> 100	> 2.4
Sedatives and Hypnotics - Barbituates - Long Duration						
Barbital Na	--	--	--	42	> 100	> 2.4
Mephobarbital	> 100	> 100	--	24	> 178	> 7.5
Metharbital	--	--	--	42	> 100	> 2.4
Phenobarbital	--	--	--	42	> 100	> 2.4
Sedatives and Hypnotics - Carbamates and Alcohols						
Chlorphenesin carbamate	> 100	> 100	--	> 100	> 100	--
Encyprate	> 100	> 100	--	> 100	> 100	--
Ethchlorvynol	--	--	--	--	42	--
Ethinimate	100	> 100	> 1.0	24	178	7.5
Mebutamate	> 100	> 100	--	75	100	1.3
Meprobamate	> 127	> 127	--	--	--	--
Valnoctamide	> 100	> 100	--	56	> 100	> 1.8
Sedatives and Hypnotics - Halogenated Hydrocarbons						
Chloral	--	--	--	> 100	> 100	--
Chloral hydrate	> 421	> 421	--	> 100	> 100	--
Chloralose	13	75	5.7	10	32	3.2
Chlorobutanol	--	--	--	> 100	> 100	--
Sedatives and Hypnotics - Others						
Capuride	> 100	> 100	--	100	> 100	> 1.0
Chlorethate	> 100	> 100	--	> 100	> 100	--
Fenchlorethate	> 100	> 100	--	> 100	> 100	--
Glutethamide	> 100	> 100	--	75	> 100	> 1.3
Mecloqualone	100	> 100	> 1.0	18	178	10
Paraldehyde	--	--	--	> 100	> 100	--
Phenaglycodol	> 100	> 100	--	32	316	10
Trimetozine	> 100	> 100	--	> 100	> 100	--

TABLE 1 (Continued)

Compound	Starling			Red-winged Blackbird		
	TI_{50} (mg/kg)	LD_{50} (mg/kg)	SF (LD_{50}/ TI_{50})	TI_{50} (mg/kg)	LD_{50} (mg/kg)	SF (LD_{50}/ TI_{50})
Tranquilizers - Benzodiazepines						
Chlordiazepoxide	75	> 100	> 1.3	7.5	316	42
Cyprazepam	> 100	> 100	--	> 100	> 100	--
Diazepam	42	> 100	> 2.4	7.5	> 316	> 42
Oxazepam	> 100	> 100	--	75	> 100	1.3
Sulazepam	> 100	> 100	--	75	> 100	> 1.3
Tranquilizers - Phenothiazines and Related Compounds - Alphatics						
Chlorpromazine HCl	> 74	> 74	--	--	--	--
Chlorpromazine SO_4	> 100	> 100	--	> 100	> 100	--
Desdimethyl chlorpromazine	> 100	> 100	--	> 100	> 100	--
Levomepromazine	> 100	> 100	--	> 100	> 100	--
Phenothiazine	> 100	> 100	--	> 100	> 100	--
Promazine	> 335	> 335	--	--	--	--
Triflupromazine	> 100	> 100	--	> 100	> 100	--
Tranquilizers - Phenothiazines and Related Compounds - Piperazine or Piperidine Derivatives						
Acetophenazine dimaleate	--	100	--	--	75	--
Clothixamide	> 100	> 100	--	> 100	> 100	--
Fluphenazine	--	562	--	--	178	--
Mepazine	--	200	--	--	--	--
Perphenazine	--	100	--	--	32	--
Trifluoperazine	> 100	> 100	--	> 100	> 100	--
Tranquilizers - Phenothiazines and Related Compounds - Xanthenes and Thioxanthenes						
Chlorprothixene	> 100	> 100	--	> 100	> 100	--
P 4657B	> 100	> 100	--	> 100	> 100	--
SKF 10810A	> 100	> 100	--	42	316	7.6
SKF 10812A	42	316	> 7.6	24	178	7.5
Xanthiol	> 100	> 100	--	> 100	> 100	--

TABLE 1 (Continued)

Compound	Starling			Red-winged Blackbird		
	TI_{50} (mg/kg)	LD_{50} (mg/kg)	SF (LD_{50}/TI_{50})	TI_{50} (mg/kg)	LD_{50} (mg/kg)	SF (LD_{50}/TI_{50})
Tranquilizers - Rauwolfia Derivatives						
Rescinnamine	--	--	--	> 100	> 100	--
Reserpine	--	--	--	75	100	1.3
Tranquilizers - Other Compounds						
Benperidol	> 100	> 100	--	100	> 100	--
Benzquinamide	> 100	> 100	--	100	> 100	1.3
Droperidol	> 100	> 100	--	100	> 100	--
Ethoxomane	> 100	> 100	--	42	100	2.4
Ex4211A	> 100	> 100	--	> 100	> 100	--
Ex5004	> 100	> 100	--	> 100	> 100	--
Hydroxyzine	> 527	> 527	--	--	--	--
Trifluoperidol	75	> 100	> 1.3	32	133	4.2
Myoneural Agents - Phenyl N-methylcarbamates						
ACD 7029	--	--	--	5.6	32	5.6
Aprocarb	7.5	13	1.8	1.6	3.8	2.4
Banol	2.1	11.5	5.6	1.8	5.6	3.2
Bay 50282	18	18	--	10	13	1.3
DRC 3340	> 100	> 100	--	56	75	1.3
DRC 3341	> 100	> 100	--	56	100	1.8
DRC 3342	> 100	> 100	--	> 100	> 100	--
DRC 3343	> 100	> 100	--	> 100	> 100	--
DRC 3344	> 100	> 100	--	> 100	> 100	--
DRC 3345	> 100	> 100	--	> 100	> 100	--
H 5727	5.4	17	3.2	3.2	10	3.2
H 8717	83	> 100	> 1.2	8.3	15	1.8
H 9699	45	45	--	4.5	45	10
HRS 1422	75	> 100	> 1.3	5.6	10	1.8
Matacil	38	> 100	> 2.6	16	50	3.2
Methiocarb	--	--	--	1.00	4.63	4.6
RE 5305	--	--	--	1.0	4.6	4.6
RE 5454	5.0	16	3.2	1.6	9.0	5.6
RE 5655	2.4	5.6	2.4	0.75	2.4	3.2
SD 8530	75	> 100	> 1.3	5.6	18	3.2
SD 8786	> 100	> 100	--	13	42	3.2
U 14540	> 100	> 100	--	> 100	> 100	--
U 17556	> 100	> 100	--	7.5	13	1.8
Zectran	16	32	2.0	4.0	11	2.7

TABLE 1 (Continued)

Compound	Starling			Red-winged Blackbird		
	TI_{50} (mg/kg)	LD_{50} (mg/kg)	SF (LD_{50}/TI_{50})	TI_{50} (mg/kg)	LD_{50} (mg/kg)	SF (LD_{50}/TI_{50})
Myoneural Agents - Phenyl Phosphonates						
Dowco 101	> 100	> 100	--	10	18	1.8
Dowco 132	100	100	--	42	100	2.4
Dowco 159	> 100	> 100	--	42	56	1.3
Dowco 160	7.5	18	2.4	2.4	10	4.2
Dowco 161	3.2	13	4.2	5.6	24	4.2
Dowco 169	42	75	1.8	10	13	1.3
Dowco 208	100	> 100	> 1.0	56	> 100	> 1.8
Dowco 210	42	> 100	> 2.4	10	24	2.4
Dowco 211	> 100	> 100	--	42	75	1.8
Dowco 217	24	56	2.4	7.5	13	1.8
Myoneural Agents - Miscellaneous - Reversible Inhibitors						
Ambenonium chloride	100	> 100	> 1.0	75	> 100	> 1.3
Carbamic acid, N-butyl	75	> 100	> 1.3	75	> 100	> 1.3
Myoneural Agents - Miscellaneous - Irreversible Inhibitors						
Azodrin	1.0	3.2	3.2	--	1.0	--
Dursban	--	75	--	10	13.3	1.3
EPN	--	7.5	--	2.4	3.2	1.3
Famophos	1.3	4.2	3.2	0.75	1.8	2.4
Golphacide	10	18	1.8	--	4.2	--
Methomyl	24	42	1.8	3.2	10	3.2
Methyl parathion	5.6	7.5	1.3	4.2	10	2.4
Parathion	4.2	5.6	1.3	--	2.4	--
Phillips 1861	--	4.9	--	1.8	2.4	1.3
Phosphamidon	2.4	5.6	2.4	0.56	1.8	3.2
Succinyl choline Cl	100	450	4.5	> 100	> 100	--
Miscellaneous Agents - Analgesics						
Acetanilide	> 100	> 100	--	> 100	> 100	--
Acetylsalicylic acid	--	--	--	100	100	--
Dimefadane	> 100	> 100	--	--	75	--
Fencafamin	> 100	> 100	--	> 100	> 100	--
Pentazocine	100	100	--	24	560	22

TABLE 1 (Continued)

Compound	Starling			Red-winged Blackbird		
	TI_{50} (mg/kg)	LD_{50} (mg/kg)	SF (LD_{50}/ TI_{50})	TI_{50} (mg/kg)	LD_{50} (mg/kg)	SF (LD_{50}/ TI_{50})
Miscellaneous Agents - Anorexogenics						
CL 24055	75	75	--	--	56	--
WY 5244	> 100	> 100	--	> 100	> 100	--
Miscellaneous Agents - Antiemetics						
Buclizine	> 100	> 100	--	> 100	> 100	--
Dimenhydrinate	> 50	> 50	--	--	--	--
Miscellaneous Agents - Antihistamine						
Chloropheniramine	> 100	> 100	--	--	75	--
Miscellaneous Agents - Antitumor						
β-Thiosemicarbazone, ethylisatin	> 100	> 100	--	> 100	> 100	--
Thiosemicarbazone, methyl glyoxol bis-(N-4-methyl)	> 100	> 100	--	> 100	> 100	--
Miscellaneous Agents - Ganglionic Blocking						
Nicotine SO_4	100	> 100	--	13	75	5.7
Trimethidinium methosulfate	> 100	> 100	--	> 100	> 100	--
Miscellaneous Agents - Muscle Relaxants						
Chlormezanone	> 100	> 100	--	> 100	> 100	--
Mephenoxalone	> 100	> 100	--	> 100	> 100	--
Metaxalone	> 100	> 100	--	> 100	> 100	--
Methocarbamol	> 100	> 100	--	> 100	> 100	--
Miscellaneous Agents - Psychotomimetics						
N-Ethyl-3-piperidyl phenylcyclopentylglycolate	> 100	> 100	--	> 100	> 100	--
Lysergide	> 32	> 32	--	--	1.8	--

TABLE 1 (Continued)

Compound	Starling			Red-winged Blackbird		
	TI_{50} (mg/kg)	LD_{50} (mg/kg)	SF (LD_{50}/TI_{50})	TI_{50} (mg/kg)	LD_{50} (mg/kg)	SF (LD_{50}/TI_{50})
Miscellaneous Agents - Spasmotic						
Tremorine	56	> 100	> 1.8	32	100	3.2
Miscellaneous Agents - Stimulants (CNS)						
Amphetamine, 3,4-dichloro	> 100	> 100	--	--	75	--
Caffeine	--	500	--	--	--	--
Pemoline	> 100	> 100	--	--	100	--
Strychnine SO_4	--	--	--	--	6	--

TABLE 2. Comparative information on the immobilization activity of 25 compounds on 9 species of birds

Compounds	Mallard Duck			Ring-necked Pheasant			Common Pigeon			Starling			Common Grackle			Red-winged Blackbird			Yellow-headed Blackbird			House Finch			House Sparrow		
	TI_{50} mg/kg	LD_{50} mg/kg	SF	TI_{50} mg/kg	LD_{50} mg/kg	SF	TI_{50} mg/kg	LD_{50} mg/kg	SF	TI_{50} mg/kg	LD_{50} mg/kg	SF	TI_{50} mg/kg	LD_{50} mg/kg	SF	TI_{50} mg/kg	LD_{50} mg/kg	SF	TI_{50} mg/kg	LD_{50} mg/kg	SF	TI_{50} mg/kg	LD_{50} mg/kg	SF	TI_{50} mg/kg	LD_{50} mg/kg	SF
General Anesthetics																											
Metomidate HCl	24	133	5.6	42	> 100	> 2.4	7.5	42	5.6	42	> 100	> 2.4	42	56	1.3	13	100	7.5	7.5	75	10	7.5	56	7.5	7.5	32	4.2
Metomidate	13	242	18	42	100	2.4	13	56	4.2	75	> 100	> 1.3	--	--	--	18	56	3.2	24	75	3.2	--	42	--	13	32	2.4
Phencyclidine	4.2	75	18	13	133	10	4.2	133	32	2.4	242	100	3.2	133	42	1.3	42	32	2.4	42	18	1.0	75	75	1.3	133	100
Local Anesthetics - Benzoic acid esters																											
Butacaine SO_4	> 100	> 100	--	75	> 100	> 1.3	> 100	> 100	--	75	> 100	> 1.3	56	> 100	> 1.8	24	100	4.2	75	> 100	> 1.3	24	242	10	56	> 100	> 1.8
Sedatives and Hypnotics - Barbiturates - short and ultrashort duration																											
Butalbital	13	56	4.2	> 100	> 100	--	24	75	3.2	42	> 100	> 2.4	--	--	--	24	100	4.2	7.5	56	7.5	18	133	7.5	42	100	2.4
Pentobarbital	13	75	5.6	100	> 100	> 1.0	24	133	5.6	56	> 100	> 1.8	24	178	7.5	7.5	75	10	75	100	1.3	13	133	10	24	75	3.2
Secobarbital	13	75	5.6	100	> 100	1.0	24	133	5.6	> 100	> 100	--	--	--	--	13	75	5.6	24	100	4.2	24	56	2.4	18	42	2.4
Thiopental	18	> 316	> 18	> 100	> 100	--	75	> 100	> 1.3	56	> 100	> 1.8	--	--	--	13	133	10	56	> 100	> 1.8	24	178	7.5	24	100	4.2
Sedatives and Hypnotics - Barbiturates - intermediate duration																											
Alloberbital	13	75	5.6	> 100	> 100	--	24	133	5.6	42	> 100	> 2.4	--	--	--	24	100	4.2	13	> 133	10	18	42	2.4	24	178	7.5
Butetbal	42	> 100	> 2.4	> 100	> 100	--	32	242	7.5	75	> 100	> 1.3	--	--	--	24	178	7.5	75	> 100	> 1.3	32	133	4.2	56	> 100	> 1.8
Talbutal	13	100	7.5	> 100	> 100	--	13	56	4.2	42	> 100	> 2.4	--	--	--	24	75	3.2	42	> 100	> 2.4	13	133	10	13	133	10
Sedatives and Hypnotics - Barbiturates - long duration																											
Mephobarbital	> 100	> 100	--	> 100	> 100	--	> 100	> 100	--	> 100	> 100	--	--	--	--	24	> 316	> 13	75	> 100	> 1.3	42	> 100	> 2.4	> 100	> 100	--
Sedatives and Hypnotics - Carbamates																											
Ethinimate	42	> 100	> 2.4	100	> 100	> 1.0	42	> 100	> 2.4	100	> 100	> 1.0	56	> 100	> 1.8	24	178	7.5	75	> 100	> 1.3	32	242	7.5	56	> 100	> 1.8
Sedatives and Hypnotics - Halogenated hydrocarbons																											
Chloralose	13	42	3.2	75	> 100	> 1.3	24	178	7.5	13	75	5.6	13	75	5.6	10	32	3.2	13	133	10	5.6	56	10	10	42	4.2
Sedatives and Hypnotics - Others																											
Mecloqualone	> 100	> 100	--	> 100	> 100	--	24	> 316	> 13	100	> 100	> 1.0	75	> 100	> 1.3	18	178	10	> 100	> 100	--	18	316	18	56	> 100	> 1.8
Phenaglycodol	75	> 100	> 1.3	100	> 100	> 1.0	> 100	> 100	--	> 100	> 100	--	> 100	> 100	--	32	316	10	> 100	> 100	--	75	> 100	> 1.3	75	> 100	> 1.3
Tranquilizers - Benzodiazepines																											
Chlordiazepoxide	75	> 100	> 1.3	> 100	> 100	--	56	> 100	> 1.8	75	> 100	> 1.3	> 100	> 100	--	7.5	316	42	> 100	> 100	--	18	316	18	24	> 316	> 13
Diazepam	10	> 316	> 32	13	> 320	> 24	13	> 316	> 24	42	> 100	> 2.4	18	> 316	> 18	7.5	> 316	> 42	3.2	> 316	> 100	0.75	> 316	>421	13	> 316	> 24
Tranquilizers - Phenothiazines and related compounds																											
SKF 10,812A	56	100	1.8	> 100	> 100	--	> 100	> 100	--	42	> 100	> 2.4	> 100	> 100	--	24	178	7.5	56	> 100	> 1.8	18	316	18	> 100	> 100	--
Myoneural Agents - Carbamates																											
ACD 7029	5.6	7.5	1.3	> 100	> 100	--	13	13	1.0	> 100	> 100	--	24	100	4.2	5.6	32	5.6	7.5	13	1.8	1.3	1.8	1.3	4.2	32	7.5
Banol	1.3	2.4	1.8	5.6	11	2.0	1.3	4.2	3.2	2.1	11.5	5.5	0.32	1.8	5.6	1.8	5.6	3.2	0.42	1.3	3.2	1.0	1.8	1.8	1.3	4.2	3.2
Methiocarb	4.2	13	3.2	100	100	--	2.4	13	5.6	6.0	13	2.1	1.8	10	5.6	1.0	4.6	4.6	1.0	3.2	3.2	2.4	2.4	1.0	4.2	18	4.2
Myoneural Agents - Phenyl phosphonothioates																											
Dowco 161	5.6	13	2.4	10	13	1.3	7.5	75	10	3.2	13	4.2	13	24	1.8	5.6	24	4.2	1.8	10	5.6	32	42	1.3	4.2	7.5	1.8
Other - Analgesics																											
Pentazocine	> 100	> 100	--	> 100	> 100	--	> 100	> 100	--	> 100	> 100	--	> 100	> 100	--	24	> 316	> 13	75	> 100	> 1.3	56	> 100	> 1.8	100	> 100	> 1.0
Other - Ganglionic blocking agent																											
Nicotine SO_4	24	75	3.2	> 100	> 100	--	42	75	1.8	100	> 100	> 1.0	> 100	> 100	--	13	75	5.6	--	42	--	0.75	100	133	> 100	> 100	--

TABLE 3. The most active immobilizing compounds on each species.

Species and Compounds	SF (LD_{50}/TI_{50})	TI_{50} (mg/kg)	LD_{50} (mg/kg)	Average Induction (Min)	Average Duration (Hrs)
Mallard Duck					
Diazepam*	32	10	> 316	23.6	2.3
Thiopental**	> 18	18	316	9.7	1.9
Phencyclidine	18	4.2	75	22.1	4.1
Metomidate*	18	13	242	10.6	1.4
Dowco 210*	13	7.5	100	32.3	1.7
Butethal*	7.5	13	100	39.8	2.5
Talbutal	7.5	13	100	16.0	3.3
Allobarbital*	5.6	13	75	15.7	2.7
Pentobarbital**	5.6	13	75	7.8	2.7
Secobarbital*	5.6	13	75	16.6	2.3
Metomidate HCl	5.6	24	133	18.6	3.1
Butalbital*	4.2	13	56	21.9	2.8
Methiocarb	3.2	4.2	13	31.6	3.3
Aprocarb*	3.2	5.6	18	27.3	1.7
Chloralose*	3.2	13	42	45.3	2.5
Nicotine SO_4*	3.2	24	75	5.1	0.3
Canada Goose					
Phencyclidine	> 10	5.6	> 56	24.0	14.0
Ring-necked Pheasant					
Diazepam*	> 42	13	> 562	9.5	3.8
Phencyclidine	10	13	133	15.3	8.0
Common Pigeon					
Phencyclidine	32	4.2	133	17.3	3.6
Diazepam*	> 24	13	> 316	17.6	2.0
Mecloqualine*	> 13	24	> 316	10.8	0.9
Dowco 161*	10	7.5	75	16.3	3.0
Chloralose*	7.5	24	178	42	2.1
Butethal*	7.5	32	242	62.3	3.0
Methiocarb**	5.6	2.4	13	10.0	1.6
Metomidate HCl**	5.6	7.5	42	8.1	1.7
Pentobarbital**	5.6	24	133	15	2.8
Secobarbital*	5.6	24	133	18.8	1.9
Metomidate*	4.2	13	56	4.4	2.2
Talbutal*	4.2	13	56	70.4	2.7
Allobarbital	4.2	24	100	54.4	12.5
Banol*	3.2	1.3	4.2	8.0	0.8
Butalbital	3.2	24	75	105.2	8.1

TABLE 3 (Continued)

Species and Compounds	SF (LD_{50}/TI_{50})	TI_{50} (mg/kg)	LD_{50} (mg/kg)	Average Induction (Min)	Average Duration (Hrs)
Mourning Dove					
Metomidate HCl*	56	2.4	133	12.6	6.4
Phencylclidine*	10	7.5	75	13.1	8.0
Chloralose	5.6	7.5	42	22.6	4.1
Starling					
Phencyclidine*	100	2.4	242	14.5	5.3
Chloralose	5.6	13	75	21.0	3.7
Banol**	5.5	2.1	11.5	8.7	1.6
Dowco 161**	4.2	3.2	13	11.3	2.2
Common Crow					
Phencyclidine*	32	7.5	240	7.3	16.0
Aprocarb*	5.6	2.4	13	7.0	0.8
Chloralose	5.6	7.5	42	38.0	6.5
Nicotine SO_4	3.2	13	42	4.5	0.8
Brown-headed Cowbird					
Nicotine SO_4*	10	3.2	32	3.5	2.5
Common Grackle					
Phencyclidine*	42	3.2	133	13.3	4.5
Diazepam*	18	18	> 316	21.5	2.3
Pentobarbital**	7.5	24	178	14.8	2.2
Banol*	5.6	0.32	1.8	16.6	2.7
Methiocarb*	5.6	1.8	10	18.4	2.0
Chloralose*	5.6	13	75	19.0	2.2
Aprocarb*	4.2	3.2	13	6.4	3.3
Dowco 210*	4.2	13	56	23.6	3.0
ACD 7029	4.2	24	100	18.6	3.1

TABLE 3 (Continued)

Species and Compounds	SF (LD_{50}/TI_{50})	TI_{50} (mg/kg)	LD_{50} (mg/kg)	Average Induction (Min)	Average Duration (Hrs)
Red-winged Blackbird					
Diazepam	> 42	7.5	> 316	18.3	4.1
Chlordiazepoxide	> 42	7.5	> 316	20.1	3.5
Phencyclidine**	32	1.3	42	13.6	3.0
Pentazocine	24	24	562	35.4	3.2
Mephobarbital	> 13	24	> 316	15.5	7.3
Phenaglycodol*	> 10	32	> 316	27.0	2.3
H 9699	10	4.2	42	22.0	3.5
Pentobarbital*	10	7.5	75	21.7	1.7
Thiopental Na*	10	13	133	20.8	2.6
Oxazepam*	10	18	178	10.3	3.5
Metomidate HCl*	7.5	13	100	6.3	1.4
Butethal	7.5	24	180	17.6	3.6
SKF 10812A	7.5	24	178	21.6	18.6
Ethinimate**	7.5	24	178	5.6	2.5
RE 5454*	6.3	1.6	10	4.3	1.8
ACD 7029**	5.6	5.6	32	11.2	2.3
Nicotine SO_4	5.6	13	75	2.3	0.4
Secobarbital**	5.6	13	75	12.3	2.5
Methiocarb*	4.6	1.0	4.6	16.5	2.9
RE 5305*	4.6	1.0	4.6	16.3	1.8
RE 5655	4.2	0.75	3.2	21.6	1.3
Dowco 160*	4.2	2.4	10	5.3	0.9
Dowco 161**	4.2	5.6	24	13.3	2.5
Butalbital	4.2	24	100	14.6	3.5
Butacaine SO_4**	4.2	24	100	8.5	1.5
Allobarbital**	4.2	24	100	12.6	2.5
Trifluoperidol	4.2	32	133	18.1	4.5
Phosphamadon*	3.2	0.56	1.8	15.6	1.5
Banol*	3.2	1.8	5.6	16.1	3.0
H 5727**	3.2	3.2	10	7.4	2.9
Methomyl*	3.2	3.2	10	14.5	3.2
Chloralose	3.2	10	32	26.3	6.3
SD 8786*	3.2	13	42	13.7	4.5
Metomidate**	3.2	18	56	5.1	2.7
Talbutal**	3.2	24	75	14.3	2.6
Tremorine	3.2	32	100	16.1	1.3

TABLE 3 (Continued)

Species and Compounds	SF (LD_{50}/TI_{50})	TI_{50} (mg/kg)	LD_{50} (mg/kg)	Average Induction (Min)	Average Duration (Hrs)
Yellow-headed Blackbird					
Diazepam**	100	3.2	316	8.5	2.7
Phencyclidine*	13	2.4	32	10.1	4.3
Metomidate*	10	7.5	75	3.6	2.2
Chloralose	10	13	133	23.0	3.1
Allobarbital	10	13	133	20.3	3.6
Butalbital	7.5	7.5	56	15.5	3.4
Probarbital Na*	7.5	24	178	29.8	2.1
Dowco 161**	5.6	1.8	10	13.6	2.2
Secobarbital**	4.2	24	100	10.4	1.8
Banol**	3.2	0.42	1.3	10.0	2.1
Methiocarb*	3.2	1.0	3.2	18.6	2.3
Metomidate*	3.2	24	75	3.2	2.2
House Finch					
Diazepam**	> 421	0.75	> 316	6.6	2.1
Nicotine SO_4	133	0.75	100	4.3	0.9
Phencyclidine*	75	1.0	75	10.6	4.5
Chlordiazepoxide*	18	18	316	12.2	1.3
SKF 10812A*	18	18	316	31.1	1.6
Mecloqualone	18	18	316	17.2	0.7
Chloralose*	10	5.6	56	16.6	2.8
Pentobarbital**	10	13	133	14.0	1.9
Talbutal*	10	13	133	12.5	3.8
Butacaine SO_4	10	24	242	14.3	1.9
Metomidate HCl**	7.5	7.5	56	7.8	2.4
Butalbital*	7.5	18	133	8.0	3.4
Thiopental*	7.5	24	178	11.0	4.1
Ethinimate*	7.5	32	242	20.0	1.5
Aprocarb**	4.2	1.8	7.5	11.6	1.5
Butethal*	4.2	32	133	18.8	3.0
White-crowned Sparrow					
Diazepam	> 5.6	18	> 100	4.0	1.2
Chloralose*	3.2	18	56	15.0	4.0
Metomidate HCl*	3.2	18	56	7.0	0.1

TABLE 3 (Continued)

Species and Compounds	SF (LD_{50}/TI_{50})	TI_{50} (mg/kg)	LD_{50} (mg/kg)	Average Induction (Min)	Average Duration (Hrs)
House Sparrow					
Phencyclidine*	100	1.3	133	6.1	3.5
Diazepam*	> 42	13	562	18.3	1.6
Chlordiazepoxide**	> 13	24	316	15.0	3.0
Talbutal**	10	13	133	6.3	2.3
ACD 7029**	7.5	4.2	32	8.6	2.0
Allobarbital	7.5	24	178	17.1	3.6
Methiocarb**	4.2	4.2	18	5.0	1.6
Metomidate HCl**	4.2	7.5	32	7.2	1.6
Chloralose*	4.2	10	42	29.2	1.8
Thiopental**	4.2	24	100	12.2	2.6
Banol**	3.2	1.3	4.2	8.5	1.0
Pentobarbital**	3.2	24	75	13.5	2.5

* Marginal

** Recommended for further trials

APPENDIX

The following list identifies all compounds tested. Product or chemical names listed are those commonly accepted by the USP (United States Pharmacopeia), NF (National Formulary), USAN (United States Adopted Name Council), or ISO (International Standards Organization), or are other officially accepted names. Following the name and the chemical description (by American Chemical Society nomenclature) is the company from which the compound was obtained.

ACD 7029 Carbamic acid, methyl, 3-isopropyl-4-methylthiophenyl ester (Allied)

ACETANILIDE N-Phenyl acetamide (Aldrich)

ACETOPHENAZINE DIMALEATE Phenothiazin-2-yl, methyl ketone, 10-{3-[4-(2-hydroxyethyl)-1-piperazinyl]-propyl}-, dimaleate (Schering)

ACETYLSALICYLIC ACID (Aldrich)

ALLOBARBITAL Barbituric acid, 5,5-diallyl (CIBA)

AMBENONIUM CHLORIDE Diethylammonium chloride, [oxalyl bis(iminoethylene)], bis [(o-chlorobenzyl)] (Winthrop)

AMPHETAMINE 3,4-DICHLORO 2-Propylamine, d-1-phenyl-3,4-dichloro-, (Aldrich)

APROCARB Carbamic acid, methyl, o-isopropoxy phenyl ester (Chemagro)

AZODRIN Phosphoric acid, dimethyl ester with 3-hydroxy-N-methyl-cis-crotonamide (Shell)

BANOL Carbamic acid, methyl, 2-chloro-4,5-xylyl ester (Upjohn)

BARBITAL SODIUM Barbituric acid, 5,5-diethyl, sodium salt (Sandoz)

BAY 50282 Carbamic acid, methyl, 3,5-dimethyl-4-diallyl aminophenyl ester (Chemagro)

BENPERIDOL 2-Benzimadazolinone, 1-{1-[3-(p-fluorobenzoyl)propyl]-4-piperidyl}-, (McNeil)

BENZQUINAMIDE 2H-Benzoquinolizine-3-carboxamide, N,N-diethyl-1,3,4,6,7,11b-hexahydro-2-hydroxy-9,10-dimethoxy-, acetate (Roerig)

BUCLIZINE Piperazine, 1-(p-chlorobenzhydryl)-4-(p-tert-butylbenzyl)-, (Pfizer)

BUTACAINE SULFATE p-Aminobenzoate, 3-(dibutylamino)-1-propyanol-, (Abbott)

BUTALBITAL Barbituric acid, 5-allyl-5-isobutyl (Sandoz)

BUTAMBEM p-Aminobenzoate, n-butyl-, (Abbott)

BUTETHAL Barbituric acid, 5-butyl-5-ethyl-, (Abbott)

CAFFEINE Xanthene, 1,3,7-trimethyl (Aldrich)

CAPURIDE Urea, 2-ethyl-3-methylvaleryl (McNeil)

CARBAMIC ACID n-BUTYL

CHLORAL Ethane, 2,2,2-trichloro (Aldrich)

CHLORAL HYDRATE 1,1-Ethanediol, 2,2,2-trichloro (Aldrich)

CHLORALOSE α-D-Glucochloralose (Aldrich)

CHLORDIAZEPOXIDE 3H,1,4-Benzodiazepine-4-oxide, 7-chloro-2-methylamino-5-phenyl (Roche)

CHLORETHATE Carbonate, bis 2,2,2-trichloroethyl (SKF)

CHLORMEZANONE 4H-1,3-thiazin-4-one, 2-(p-chlorophenyl)tetrahydro-3-methyl-1, 1-dioxide (Winthrop)

CHLOROBUTANOL 2-Propanol, 1,1,1-trichloro-2-methyl-, (Parke-Davis)

2-CHLOROPROCAINE HYDROCHLORIDE Benzoic acid, 2-chloro-4-amino, 2-(diethylamino)ethyl ester HCl (Strasenburgh)

CHLORPHENESIN CARBAMATE Carbamic acid, 3-(p-chlorophenoxy)-2-hydroxypropyl ester (Upjohn)

CHLORPHENIRAMINE Pyridine, 2[p-chloro-α(2-dimethylaminoethyl)benzyl]maleate (Hexagon)

CHLORPROMAZINE Phenothiazine, 2-chloro-10-[3-(dimethylamino)propyl] HCl (SKF)

CHLORPROMAZINE SULFATE Phenothiazine, 2-chloro-10-[3-(dimethylamino)propyl] SO_4 (SKF)

CHLORPROTHIXENE Thioxanthene, -Δ9,α-propylamine-2-chloro-N,N-dimethyl HCl (Hoffman-LaRoche)

CL 24055 Acetanelide, 4'-dimethyltriazino (American Cyanamid)

CLOTHIXAMIDE Piperazine propionamide, 1-4[3-(2-chlorothioxanthen-9-ylidene) propyl]-N-methyl dimaleate (Pfizer)

CYCLOBARBITAL Barbituric acid, 5-ethyl, 5-(1-cyclohexenyl) (Winthrop)

CYPRAZEPAM 3H-1,4-Benzodiazepam-1-4-oxide, 7-chloro-2-[(cyclopropylmethyl)-amino]-5-phenyl (Warner-Lambert)

DESDIMETHYL CHLORPROMAZINE Phenothiazine, 2-chloro-10-(3-aminopropyl) (Lakeside)

DIAZEPAM 2H,1,4-Benzodiapepin-2-one, 7-chloro-1,3-dihydro-1-methyl-5-phenyl-, (Hoffman-LaRoche)

DIBUCAINE HYDROCHLORIDE Cinchoninamide, 2-butoxy-N-(2-diethylaminoethyl) HCl (CIBA)

DIMEFADANE 1-Indanamine, N,N-dimethyl-3-phenyl, (SKF)

DIMENHYDRINATE 8-Chlorotheophillinate, 2-(benzohydryloxy)-N,N-dimethylethylamine (Searle)

DIPERODON HYDROCHLORIDE 1,2-Propanediol, 3-piperidino dicarbanilate ester HCl (Merrill)

DOWCO 101 Phosphoric acid, dimethyl, (2,4,5-trichlorophenyl) (Dow)

DOWCO 132 Phosphoroamidic acid, methyl, 4-tert-butyl-2-chlorophenyl methyl ester (Dow)

DOWCO 159 Phosphoroamidic acid, ethyl, methyl-2,4,5-trichlorophenyl ester (Dow)

DOWCO 160 Phosphoroamidic acid, ethyl, 2,4,5-trichlorophenyl ester (Dow)

DOWCO 161 Phosphoroamidic acid, ethyl, 2,4-dichlorophenyl ester (Dow)

DOWCO 169 Phosphoroamidic acid, N,N'-dimethylphenyl ester (Dow)

DOWCO 208 Phosphoroamidic acid, ethyl, 2,4,5-trichlorophenyl ester (Dow)

DOWCO 210 Phosphoroamidic acid, ethyl, ethyl-2,4,5-trichlorophenyl ester (Dow)

DOWCO 211 Phosphoroamidic acid, sec-butyl, ethyl-2,4,5-trichlorophenyl ester (Dow)

DOWCO 217 Phosphorothioic acid, O,O-dimethyl, O-(3,5,6-trichloro-2-pyridyl) ester (Dow)

DRC-3340 Carbamic acid, methyl, 3,5-xylyl ester (Schafer)

DRC-3341 Carbamic acid, methyl, 3-tolyl ester (Schafer)

DRC-3342 Carbamic acid, methyl, 4-chloro-3,5-xylyl ester (Schafer)

DRC-3343 Carbamic acid, methyl, 4-chlorophenyl ester (Schafer)

DRC-3344 Carbamic acid, methyl, 4-chloro-3-tolyl ester (Schafer)

DRC-3345 Carbamic acid, methyl, phenyl ester (Schafer)

DROPERIDOL 2-Benzimidazolinone, 1-{1-[3-(p-fluorobenzoyl)propyl]-1,2,3,6-tetrahydro-4-pyridyl}-, (McNeil)

DURSBAN Phosphorothioic acid, O,O-diethyl O-3,5,6-trichloro-2-pyridyl ester (Dow)

ENCYPRATE Carbamic acid, N-benzylcyclopropane ethyl ester (Abbott)

EPN Phosphonothioic acid, phenyl-, O-ethyl, O-p-nitrophenyl ester (duPont)

ETHCHLORVYNOL 1-Chloro-3-ethyl-1-penten-4-yn-3-ol (Abbott)

ETHINAMATE Carbamic acid, 1-ethynylcyclohexyl ester (Lilly)

ETHOMOXANE 1,4-Benzodioxan, 8-ethoxy-2-(n-butylaminomethyl)-, HCl (Lilly)

ETHYL AMINOBENZOATE p-Aminobenzoic acid, ethyl-, (Aldrich)

N-ETHYL-3-PIPERIDYL PHENYLCYCLOPENTYLGLYCOLATE Mandelic acid, α-cyclopentyl-, 1-ethyl-3-piperidyl ester HCl (Lakeside)

EX 4211-A 1,2,3-Benzothiadiazine, 4-hydrazino-1,1-dioxide HCl (Lakeside)

EX 5004 2H,1,2,4-Benzothiadiazine, 6-chloro-3,4-dihydro-3-(3-oxo-n-propyl)-7-sulfamyl-1,1-dioxide phthalazone-azine (Lakeside)

FAMOPHOS Phosphorothioic acid, O,O-Dimethyl ester O ester with p-hydroxy-N-N-dimethyl benzenesulfonamide (American Cyanamid)

FENCAMFAMIN 2-Norbornanamine, N-ethyl-3-phenyl (Lakeside)

FENCLORETHATE Carbamic acid, ethyl, p-acetamidophenyl-2,2,2-trichloro ester (SKF)

FLUPHENAZINE 1-Piperazine ethanol, 4-{3-[2-(trifluoromethyl)-phenothiazin-10-yl]propyl}diHCl (Squibb)

GLUTETHIMIDE Glutarimide, 2-ethyl-2-phenyl (CIBA)

GOLPHACIDE Phosphoroamidothioic acid, O,O-bis(p-chlorophenyl)acetimidoyl ester (Chemagro)

H 5727 Carbamic acid, methyl, m-isopropyl phenyl ester (Hercules)

H 8717 Carbamic acid, methyl, m-(2-propynyloxy)phenyl ester (Hercules)

H 9699 Carbamic acid, methyl, o-(2-propynyloxy)phenyl ester (Hercules)

HEXOBARBITAL SODIUM Barbituric acid, 5-(1-cyclohexen-1-yl)-1,5-dimethyl sodium salt (Winthrop)

HRS 1422 Carbamic acid, methyl, 3,5-diisopropylphenyl ester (Hooker)

HYDROXYDIONE 5 β-Pregnane-3,20-dione-21-hydroxy sodium hemisuccinate (Pfizer)

HYDROXYZINE Ethanol, 2-{2-[4-(p-chloro phenylbenzyl)-1-piperazinyl]ethoxy} diHCl (Roerig)

ISOPENTYLHYDROCUPREINE Hydrocupreine, ether isopentyl (White)

LEVOMEPROMAZINE Phenothiazine, 10-(3-dimethylamino-2-methylpropyl)-2-methoxy (Lederle)

LYSERGIDE Lysergamid, N,N-diethyl (Sandoz)

MATACIL Carbamic acid, methyl, 4-dimethylamino-3-tolyl ester (Chemagro)

MEBUTAMATE Carbamic acid, 2-sec-butyl-2-methyl trimethylene ester (Wallace)

MECLOQUALONE 4(3H)-Quinazolinone, 3-(o-chlorophenyl)-2-methyl (Warner-Lambert)

MEPAZINE Phenothiazine, 10-[1-methyl-3-(piperidyl)methyl] HCl (Warner-Chilcott)

MEPHENOXALONE 2-Oxazolidinone, 5-[(o-methoxyphenoxy)methyl] (Lakeside)

MEPHOBARBITAL Barbituric acid, 5-ethyl-1-methyl-5-phenyl (Winthrop)

MEPROBAMATE Carbamic acid, 2-methyl-2-propyl trimethylene ester (Wyeth)

METAXALONE 2-Oxazolidinone, 5-(3,5-dimethylphenoxymethyl) (Robins)

METHARBITAL Barbituric acid, 5,5-diethyl-1-methyl (Abbott)

METHIOCARB Carbamic acid, methyl, 4-methylthio-3,5-xylyl ester (Chemagro)

METHOCARBAMOL 1,2-Propanediol, 3-(o-methoxyphenoxy)-

METHOMYL Acetimidothioic acid, methyl, N-methylcarbamoyl ester (du Pont)

METHYL PARATHION Phosphorothioic acid, O,O-dimethyl O-p-nitrophenyl (Stauffer)

METOMIDATE Imidizole, 5-carboxylic acid, 1-(α-methylbenzyl)methyl ester (McNeil)

METOMIDATE HYDROCHLORIDE Imidazole, 5-carboxylic acid, 1-(α-methylbenzyl)methyl ester HCl (McNeil)

NICOTINE SULFATE Pyrrolidine, 1-methyl-2-(3-pyridyl)sulfate (Aldrich)

OXAZEPAM 2H,1,4-Benzodiazepin-, 7-chloro-3-hydroxy-5-phenyl-1,3-dihydro-2-one (Wyeth)

OXETHAZAINE Oxaine, N,N-bis(N-methyl-N-phenyl-tert-butylacetamide)-β-hydroxy-ethylamine (Wyeth)

PARALDEHYDE (Aldrich)

PARATHION Phosphorothioic acid, O,O-diethyl O-p-nitrophenyl ester (Stauffer)

PEMOLINE 4-Oxazolidinone, 2-imino-5-phenyl (Abbott)

PENTAZOCINE 3-Benzazocin-8-ol, 1,2,3,4,5,6-hexahydro-6,11-dimethyl-3-(3-methyl-2-butenyl)-2,6-methano-, (Winthrop)

PENTOBARBITAL Barbituric acid, 5-ethyl-5-(1-methylbutyl) (Abbott)

PERPHENAZINE 1-Piperazineethanol, 4-[3-(2-chlorophenothiazin-10-yl)propyl] (Schering)

P-4657-B Thioxanthene, 2-dimethylsulfamyl[9-(4-methyl-1-piperazinyl)-propylidine] (Pfizer)

PHENAGLYCODOL 2,3-Butanediol, 2-(p-chlorophenyl)-3-methyl (Lilly)

PHENCYCLIDINE Piperidine, 1-(1-phenylcyclohexyl) HCl (Parke-Davis)

PHENOBARBITAL Barbituric acid, 5-ethyl-5-phenyl (Winthrop)

PHENOTHIAZINE Parke-Davis)

PHILLIPS 1861 Pyridine, 4-amino (Phillips)

PHOSPHAMIDON Phosphoric acid, dimethyl ester, ester with 2-chloro-N,N-diethyl-3-hydroxy crotonamide

PRAMOXINE Morpholine, 4-[3-(p-butoxyphenoxy)propyl] HCl (Abbott)

PRILOCAINE o-Toluidide, 2-propylamino propiono HCl (Astra)

PROBARBITAL SODIUM Barbituric acid, 5-ethyl-5-isopropyl sodium salt (Squibb)

PROCAINE p-Aminobenzoic acid, 2-diethylaminoethyl HCl (Parke-Davis)

PROMAZINE Phenothiazine, 10-(3-dimethylamino propyl) HCl (Wyeth)

RESCINNAMINE (Aldrich)

RESERPINE (Aldrich)

RE 5305 Carbamic acid, methyl, 3-sec-butylphenyl (Ortho)

RE 5454 Carbamic acid, methyl, 2-chloro-5-tert pentylphenyl (Ortho)

RE 5655 Carbamic acid, methyl, 2-chloro-5-sec butylphenyl (Ortho)

SD 8530 Carbamic acid, methyl, 3,4,5-trimethylphenyl (Shell)

SD 8786 Carbamic acid, methyl, 2,3,4-trimethylphenyl (Shell)

SECOBARBITAL Barbituric acid, 5-allyl-5-(methylbutyl) (Lilly)

SKF 10810A Methylxanthene, 9(3-dimethylaminopropyl)-2-trifluoro HCl (SKF)

SKF 10812A Methylxanthene, trans-9-(3-diethylaminopropyl)-2-trifluoro HCl (SKF)

STRYCHNINE SULFATE (Aldrich)

SUCCINYL CHOLINE CHLORIDE (Abbott)

SULAZEPAM 4-Benzodiazepine-2-thione, 7-chloro-1,3-dihydro-1-methyl-5-phenyl (Warner-Chilcott)

TALBUTAL Barbituric acid, 5-allyl-5-sec-butyl (Winthrop)

TETRACAINE p-Butylaminobenzoic acid, 2-(dimethylamino)ethyl ester HCl (Winthrop)

THIAMYL SODIUM Barbituric acid, 5-allyl-5-(1-methylbutyl)-2-thio sodium salt (Parke-Davis)

THIOPENTAL SODIUM Barbituric acid, 5-ethyl-5-(1-methylbutyl)-2-thio sodium salt (Abbott)

β-THIOSEMICARBAZONE ETHYLISATIN (Nutritional Biochem.)

THIOSEMICARBAZONE METHYL GLYOXOL BIS-(N-4-METHYL)(Nutritional Biochem.)

TREMORINE Dipyrrolidine, 1,1'-(2-butynylene) (Abbott)

TRIBROMOETHANOL (Winthrop)

TRICAINE m-Aminobenzoic acid, ethyl-, methane sulfonate salt (Sandoz)

TRIFLUOPERAZINE Phenothiazine, 10-[3-(4-methylpiperazin-1-yl)propyl]-2-trifluoro-methyl diHCl (SKF)

TRIFLUOPERIDOL Buterophenone, 4'-fluoro 4-[4-hydroxy-4-(α,α,α-trifluoro-m-tolyl)-piperadino (McNeil)

TRIFLUOPROMAZINE Phenothiazine, [10-(3-dimethylamino)propyl]-2-trifluoromethyl HCl (Squibb)

TRIMETHIDINIUM METHOSULFATE 1,3,8,8-Tetramethyl-3-azoniabicyclo[3,2,1]octane, 3-[3-(dimethylamino)propyl]-methylsulfate methosulfate (Wyeth)

TRIMETOZINE Morpholine, 4-(3,4,5-trimethoxybenzoyl) (Abbott)

U 14560 Carbamic acid, methyl, 2,4-dichloro-3,5-xylyl ester (Upjohn)

U 17556 Carbamic acid, methyl 2,4-dichloro-5-ethyl m-tolyl ester (Upjohn)

VALNOCTAMIDE 3-Methylvaleramide, 2-ethyl (McNeil)

WY 5244 2,5-Benzodiazocine, 1-(p-chlorophenyl)-1,2,3,4,5,6-hexahydro HCl (Wyeth)

XANTHIOL 1-Piperazine propanol, 4-[3-(2-chlorothioxanthen-9-yl)propyl] diHCl (Roerig)

ZECTRAN Carbamic acid, methyl, 4-dimethylamino-3,5-xylyl ester (Dow)

ZOLAMINE Thiazole, 2-[(2-dimethylaminoethyl)(p-methoxybenzyl)amino] (White)

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